

THE INCIDENCE OF RABIES IN ANIMALS IN THE REPUBLIC OF MOLDOVA DEPENDING ON THE VACCINATION OF FOXES IN THE SYLVATIC ENVIRONMENT

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Abstract

*The study presents the results of the research on the epidemiological situation of the rabies virus following the vaccination campaign of the fox population in the sylvatic environment in the last 5 years on the territory of the Republic of Moldova. Both in Europe and in the Republic of Moldova, *Vulpes vulpes* represents in the sylvatic environment the main vector of the spread of rabies in wild and domestic animal populations. In 2019-2023 in the Republic of Moldova were registered 12 species of animals that reacted positively to the rabies virus. The most frequent cases of rabies in animals were registered in cattle, dogs, foxes, cats and constituted 93.72% of the total number of registered cases (239). Following the start in 2020 of the fox vaccination campaign, there was observed a decrease in the incidence of rabies in 2021 by 74.73%, in 2022 by 85.71% and in 2023 by 76.92% compared to 2019. The obtained data demonstrate that the application of vaccine baits by air and land has led to the immunization of wild animals and the reduction of the sick animals number.*

Key words: red fox, rabies, vaccination, animal biodiversity.

INTRODUCTION

Rabies is spread all over the globe and, without being influenced by climate or season, can have a sporadic or even epizootic character. Rabies is a disease with a natural focus. The rabies virus is preserved only in the organism of infected animals, which constitute the natural reservoirs of infection. According to Mânzat (Mânzat, 2005), two types of rabies virus reservoirs are distinguished: "domestic" or "urban" - made up of domestic animals (dogs, cats and less often cattle, horses, pigs) and "sylvatic" or "wild" - made up of numerous wild animals (foxes, wolves, badgers, otters, jackals, hyenas, rats, mice, rabbits et al.). Between the two reservoirs there are reciprocal relations. For example, in most cases of "urban" rabies in Europe, the dog intervenes, and in "sylvatic" rabies, the main role is played by the fox. It is known that the incidence of rabies varies over time and differs from one country to another, it is conditioned by

the geographical position, the dynamics of the population development of the animal species, the state of their immunity and the veterinary sanitary measures undertaken. In the world annually more than 60,000 cases of rabies in animals are registered. In Europe, the red fox represents the natural reservoir of rabies and the main vector of its spread in wild and domestic animal populations. (OIE, 2021; WHO, 2018; WHO, 2021; Mânzat, 2005).

In the Republic of Moldova, a relatively large number of rabies cases are registered annually in relation to the surface of the country's territory. According to the study carried out in the years 2012-2021 there were registered 1156 cases of rabies in domestic and wild animals, which constitutes an average of 115.6 cases per year (Balacci et al., 2022). The incidence of rabies in various animal species is similar to the incidence of rabies in animals in European Union (EU) countries. Thus, in the sylvatic environment the most affected animal species is the red fox and

it constitutes 16.26% of the total number of animals affected in the period 2012-2021 (Balacci & Balan, 2022).

The beginning of the spread of sylvatic rabies in Europe was recorded during the Second World War, when the first cases were discovered at the former Russian-Polish border (Bourhy et al., 1999). The disease spread progressively from the north-east to the center and south-west of Europe (Aubert et al., 2004; Pastoret & Brochier, 1999). The first country to launch a massive oral rabies vaccination (ORV) campaign using attenuated vaccines was Switzerland in 1978 (Wandeler et al., 1988). In EU countries, large-scale rabies eradication programs in wildlife using ORV started in 1989 due to funding specified for this purpose by the EU (Müller et al., 2015). It has been established and demonstrated that the vaccination campaign represents the only effective means of controlling rabies in livestock (Müller & Freuling, 2018; OIE, 2022).

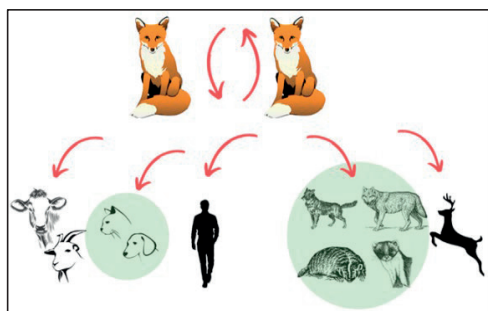


Figure 1. Transmission and maintenance of RABV among the population of the primary carnivorous reservoir host (red fox) (Müller et al., 2015)

In the current epidemiological context of the evolution of rabies both on the national territory and in the neighboring countries, it is necessary to establish measures to prevent the occurrence of cases of the disease in the Republic of Moldova. To reduce the number of rabies cases, the Republic of Moldova joined the OIE, WHO and FAO initiative to combat rabies. Thus, in 2019, he approved the "Plan of measures for surveillance, control and eradication of rabies in foxes in the Republic of Moldova for the years 2019-2023" which provides for the vaccination of foxes in the forest environment (HG 185/2019, 2019).

MATERIALS AND METHODS

The start of the anti-rabies vaccination campaign for foxes through the distribution of vaccine baits and related activities began in 2020. In 2020, the vaccination campaign was carried out 2 times (the spring campaign and the autumn campaign) and covered the entire accessible area for the distribution of vaccine baits on the territory of the Republic of Moldova. Both campaigns were carried out within 15 calendar days. For the implementation of the Action Plan were distributed rabies vaccine baits for oral immunization "Lysvulpen" produced by Bioveta, a.s., Czech Republic (Figure 2).

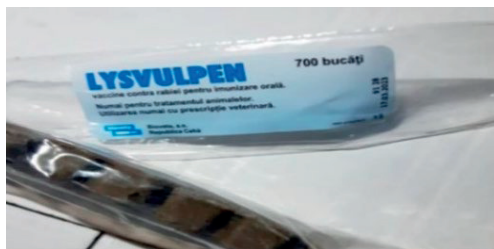


Figure 2. Vaccine baits against rabies "Lysvulpen" (own source)

The spring and autumn distribution of vaccine baits was carried out by air and by land, taking into account and in accordance with the physiological and biological states of the red fox organism, characteristic for these seasons, as well as with the environmental conditions and abiotic factors (Anderson et al., 1981; Smith & Wilkinson, 2003). For the distribution of vaccine baits by air and cover the entire area planned for vaccination, which constituted 21725.42 km², four specially equipped aircraft were used for this purpose (Figure 3).



Figure 3. Aircraft used to distribute of vaccine baits "Lysvulpen" (own source)

The distribution of baits was made automated by means of a "vaccine thrower" with a frequency of 25 vaccine baits per 1 km² (EC, 2002; AHAW, 2015) and at a distance between the flight lines of 500 meters. According to the scheme drawn up for the distribution of vaccine baits, the aircraft flew at low altitudes, up to 300m from the ground level and had a flight speed adapted accordingly to the homogeneous distribution of vaccine baits.

The land-based vaccination was carried out by the authorized staff of the territorial subdivisions of the National Agency for Food Safety and by the staff of the Moldsilva Agency and the Society of Hunters and Fishermen of the Republic of Moldova through the manual distribution of the vaccine baits at each entrance to the burrow, on the fox's trails and in the immediate vicinity of the burrows (Figure 4).



Figure 4. Manual distribution of vaccine baits at burrow entrance (own source)

After the distribution of the vaccine baits, the free movement of dogs and cats was restricted as far as possible, since these animals could disrupt the proper progress of the vaccination campaign by the fact that they could have consumed the distributed baits. Also, in the regions where the vaccine baits were distributed, hunting was prohibited for a period of 14 days from their distribution.

The number of vaccine baits distributed on the national territory according to the "Plan of measures for surveillance, control and eradication of rabies in foxes in the Republic of Moldova for the years 2019-2023" is represented in Table 1.

Table 1. The number of vaccine baits distributed on the national territory in 2020-2021 (pcs.)

Year of distribution of baits	Distribution of baits				Total number of baits distributed (pcs.)
	By air (pcs.)		By land (pcs.)		
	Spring campaign	Autumn campaign	Spring campaign	Autumn campaign	
2019	0	0	0	0	0
2020	515 746 july	570 526 november	73 800 july	73 800 november	1 233 872
2021	0	606 465 october	0	52 000 october	658 465
2022	0	0	0	0	0
2023	0	0	0	0	0

The costs foreseen for the implementation of the Plan of measures for surveillance, control and eradication of rabies in animals for the years 2020-2023 are presented in Table 2.

Table 2. Costs foreseen for the implementation of the Plan of measures for surveillance, control and eradication of rabies in animals for the years 2020-2023 (mdl)

No.	Proposed action	Planned costs per year (mdl)	Actual costs incurred according to the years (mdl)				
			2019	2020	2021	2022	2023
1	Aerial distribution of vaccine baits and related activities	23 351 689	0	22 723 048	12 330 957	0	0
2	Control of virus concentration on cell cultures from immunological veterinary medicinal products	0	0	23 760	15 290	0	0
3	Establishing post-vaccination efficacy (active and passive rabies surveillance)	1 403 154	0	644 686	689 400	0	0
4	Elaboration and distribution of leaflets intended to inform the population	35 000	0	24810	17 466	0	0
Total		24 789 843	0	23 416 304	13 053 113	0	0

RESULTS AND DISCUSSIONS

Rabies is characterized by a cyclical evolution of the disease. Under natural conditions, direct contact between sick and sensitive animals is necessary for the development of a rabies epizootic, and each diseased animal must infect more than one susceptible animal, otherwise the epizootic will die out.

The start of the works of the anti-rabies vaccination campaign for foxes through the distribution of vaccine baits and related activities was planned for 2019, but for organizational reasons the campaign started only in 2020, which was directly reflected proportionally to the large number of diseases of various species of animals with the rabies virus. Animal rabies disease according to animal species is presented in table 3.

Table 3. The number of rabies cases in the Republic of Moldova registered by animal species for the years 2023-2019

Animal species	Number of cases					Total for 5 years	%
	2023	2022	2021	2020	2019		
Bovine	3	7	8	39	34	91	38.07
Dog	9	3	8	20	22	62	25.52
Fox	4	1	3	15	16	39	16.31
Cat	4	1	3	12	12	32	13.39
Goat	0	0	1	0	1	2	0.84
Marten	1	0	0	0	1	2	0.84
Polecat	0	0	0	1	2	3	1.25
Horse	0	0	0	2	0	2	0.84
Swine	0	0	0	0	1	1	0.42
Wild cat	0	0	0	0	1	1	0.42
Jackal	0	1	0	2	0	3	1.25
Badger	0	0	0	0	1	1	0.42
Total per year	21	13	23	91	91	239	100

The data presented in Table 3 show that in the Republic of Moldova in 2019 were registered 91 cases of animal rabies. In 2020, although the process of implementing the red fox vaccination program started by distributing 1 233 872 vaccine baits, were also registered 91 cases of rabies. That is, no reductions in rabies cases are noted, resulting from the campaign to vaccinate the herd of wild animals. In this context, it is worth mentioning, that the high number of registered rabies cases is basically due to the fact

that the organism of animals subject to vaccination in 2020 did not have sufficient time or adequate conditions to develop an integral specific immunity.

The data of the table show that in 2021 there is a significant decrease of 74.72% of cases of animals rabies compared to 2020. Subsequently, in 2022 there were 13 cases of rabies in animals, which represents a decrease of 85.71% compared to 2020 and 43.47% compared to 2021. At the same time, there is also a change in the number of rabies cases depending on the animal species. Thus, if in 2020 the number of cases of rabies in foxes from the total species of sick animals constituted 16.48%, in 2021 it was significantly reduced and constituted 13.04%, and in 2022 it constituted 7.69% of cases.

A similar trend was also observed in cattle where the number of rabies cases during this period decreased from 39 cases in 2020 to 8 cases in 2021, to 7 cases in 2022 and to 3 cases in 2023.

In this context, it can be mentioned that with the implementation of the oral anti-rabies vaccination program for foxes, there was a decrease of rabies cases among them. As an unwanted result of this campaign, a significant increase in cases of rabies in dogs was identified. Thus, in 2020 the number of sick dogs constituted 21.98% (20 cases out of 91), and in 2023-42.86% (9 cases out of 21) of the total number of sick animals. According to the data obtained it can be mentioned that, there was a redistribution of the rabies virus by decreasing it in the wild fauna and increasing it in the urban area. Therefore, in this case it is necessary to implement a more rigorous vaccination campaign for pets and especially dogs.

We further mention that in the year 2023 there is 1.62 times increase in the number of animals sick with the rabies virus compared to the year 2022. We believe that this result is caused by the fact that in the years 2022 and 2023 the vaccination program was not implemented; thus, wild animals were not vaccinated with vaccine baits. As a consequence, the specific immunity obtained previously in the years 2020 and 2021 was not sufficient to protect the animals against the rabies virus in the year 2023 as well.

Next, the number of rabies cases was investigated according to the season of the year. Data on the number of animal diseases

according to the months of the year are presented in Table 4.

Table 4. The number of rabies cases in the Republic of Moldova registered by month during the years 2023-2019

Month of registration of illness	Year of registration of illness, heads					Total illnesses for 5 years	
	2023	2022	2021	2020	2019	heads	%
January	2	0	4	9	2	17	7.12
February	3	0	3	8	7	21	8.78
March	4	2	3	11	5	25	10.46
April	1	1	2	6	2	12	5.02
May	1	0	5	2	2	10	4.18
June	3	0	2	4	6	15	6.28
July	0	1	1	6	5	13	5.44
August	0	1	2	11	12	26	10.88
September	4	3	0	12	8	27	11.29
October	0	2	1	14	16	33	13.81
November	0	1	0	6	17	24	10.04
December	3	2	0	2	9	16	6.69
Total per year	21	13	23	91	91	239	100

From the data of table 4 it can be seen that in the period before the vaccination period (2019) the rabies virus in animals is recorded practically throughout the year. With the consumption of vaccine baits and the formation in animals of specific resistance against the rabies virus, cases of illness were not recorded in all months of the year. Thus, in 2021, rabies cases were recorded in 9 months of the year, in 2022 - in 8 months of the year and in 2023, also - in 8 months of the year. At the same time, it is worth mentioning that there is no obvious correlation between the number of animal diseases and the season of the year. Therefore, practically, the incidence of rabies in animals in the researches carried out depends, on the one hand, to a greater extent on their physiological needs, such as acquiring food, caring for offspring, the reproduction process, the expression of territorial behavior (marking and defending the territory et al.), migration and others, and on the other hand, to a lesser extent depends on abiotic environmental factors.

Next, the geographical distribution of rabies cases on the national territory was studied. Thus, it was determined that this distribution is uneven. The major number of disease cases in all animal species was recorded in the Central

and Northern Region (Slobozia, Sângerei, Edineț and Briceni), and the minimum number of diseases was recorded in the Southern Region of the country.

CONCLUSIONS

In the 21st century, rabies remains one of the most feared and important threats to public health. The evolution of rabies in the Republic of Moldova was and continues to remain endemic, thus constituting a vital danger for humans and animals and a barrier in the intra-community circulation of animal products, agricultural animals, including pets. Oral vaccination of wild animals is the only effective tool to eradicate rabies in wildlife. From the data presented in this research, it can be mentioned that the rabies virus in animals on the territory of the Republic of Moldova evolves sporadically. The fox represents one of the natural reservoirs of rabies and the main vector of the spread of rabies in wild and domestic animal populations, including among the human population. Thus, it is necessary to strengthen the veterinary sanitary activity for the purpose of surveillance, control, prophylaxis and eradication of rabies in animals from the sylvatic environment. At the same time, it is necessary for the long-term continuous implementation of the "Plan of measures for surveillance, control and eradication of rabies in foxes in the Republic of Moldova for the years 2019-2023" and it is also appropriate to make a constant political and financial commitment from on the part of the state and close cooperation between neighboring countries in order to jointly eradication of the disease.

Previously in the Republic of Moldova during the period of 2012-2021 there were registered 1156 (on average 115.6 cases per year) cases of rabies, which included 20 species of animals from all districts of the country. During the research period between the years 2021-2023 there were registered 57 cases of illness with the rabies virus (on average 19 cases per year) which included 7 species of animals.

Therefore, in order to fortify the results obtained from the vaccination of foxes with vaccine baits (in the medium and long term) and in order to prevent the danger of the emergence of new cases of disease as a result of the epidemiological situation in neighboring

countries, it is necessary to continue the anti-rabies vaccination program of foxes, dogs and in some cases of agricultural animals, approved by the Government of the Republic of Moldova in accordance with the approval of similar acts by the Governments of neighboring countries and the taking of concomitant measures to combat against rabies. In support of this action is also the following argument, that in the year 2021 only one vaccination campaign was carried out, and in the years 2022 and 2023 none, a fact that led to the increase of registered cases of rabies in animals in the years 2022 and 2023. In this vein, we mention that the missed vaccination campaigns will in the near future have a devastating impact on the rabies eradication programs and a considerable increase in the cases of animal diseases with the rabies virus and the existence of an obvious danger for *homo sapiens*.

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